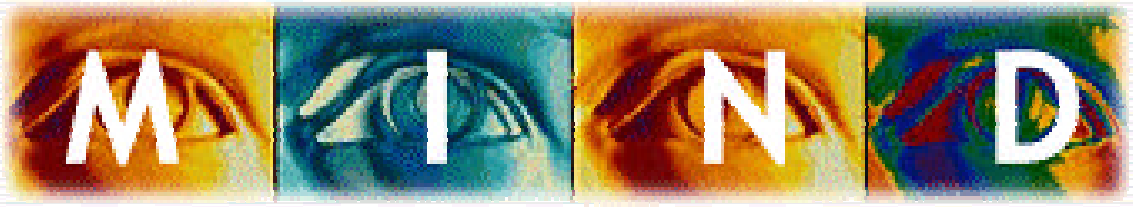

Resource Selection and Data Fusion for Multimedia International Digital Libraries

The MIND Approach

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Open Archive Forum Workshop

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Outline

- Project organisation
- Motivations, assumptions and main issues
- Architecture
- Searching distributed multimedia DLs with MIND
- MIND components of interest to OA Forum:
  - Resource description acquisition
  - Schema mapping

Project Organisation

- MIND: Resource Selection and Data Fusion in Multimedia Distributed Digital Libraries
- IST-RTD FP5 project
- Duration:
  - January 2001 - June 2003 (30 months)
- Project participants:
  - University of Strathclyde (UK) (coordinator)
  - University of Dortmund (Germany)
  - University of Florence (Italy)
  - University of Sheffield (UK)
  - Carnegie Mellon University (USA)
- More info at: http://www.mind-project.net/

Motivations

- Goal: enable searching hundreds of DLs using one distributed content-based access system
  - heterogeneity (in query language, schema, etc.)
  - multimedia (text, images, speech)
- Assumptions:
  - minimal level of standardisation and cooperation
    - cooperative and non-cooperative DLs
  - simplest possible query interface (Google style)
  - user interested in high precision searches

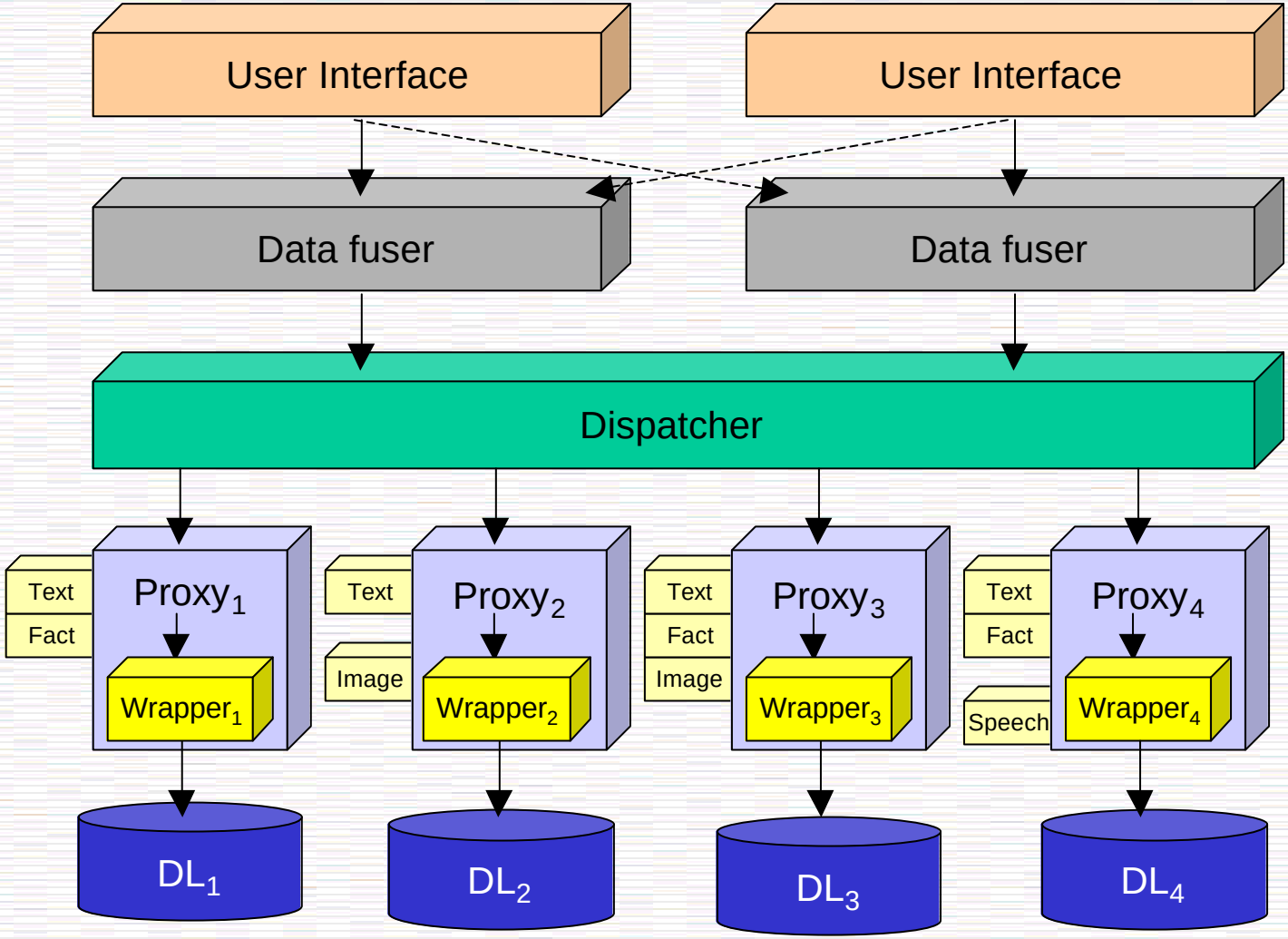
Main Issues

- Content-based access to information
- No local repository!
- Main issues:
  - resource descriptions
  - resource selection
  - schema mapping
  - data fusion
  - presentation of results and user interfaces
- Different levels of success in dealing with these issues in the project

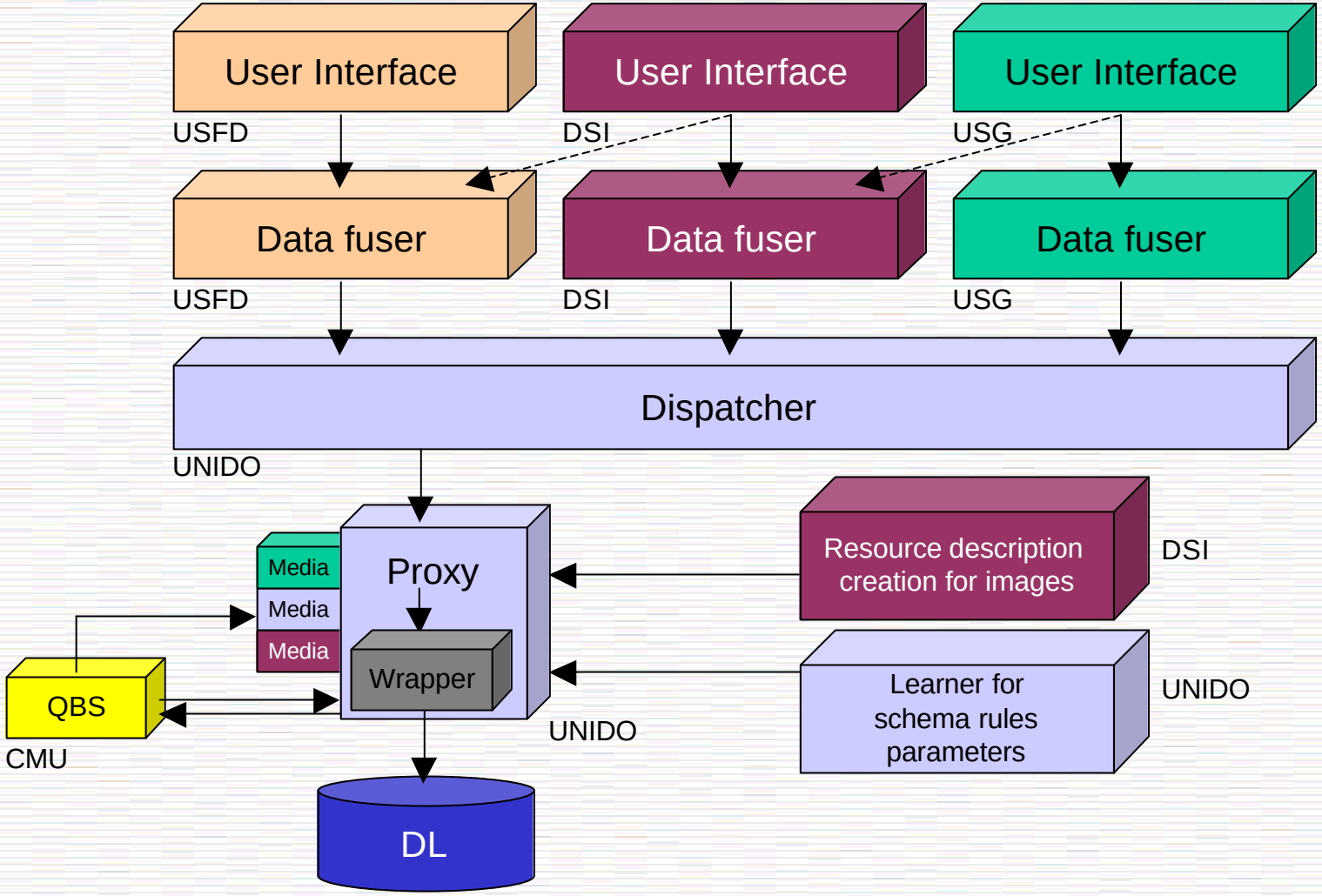
MIND Architecture

- Design goals:
  - Distributed environment, different languages/OS
  - Modification/extension can be done easily
    - New DLs
    - New media types
    - New functionalities
- Solutions:
  - Specific components for different parts, e.g.
    - Proxy component for DL
    - Media-specific components
  - Communication via SOAP (XML, HTTP)

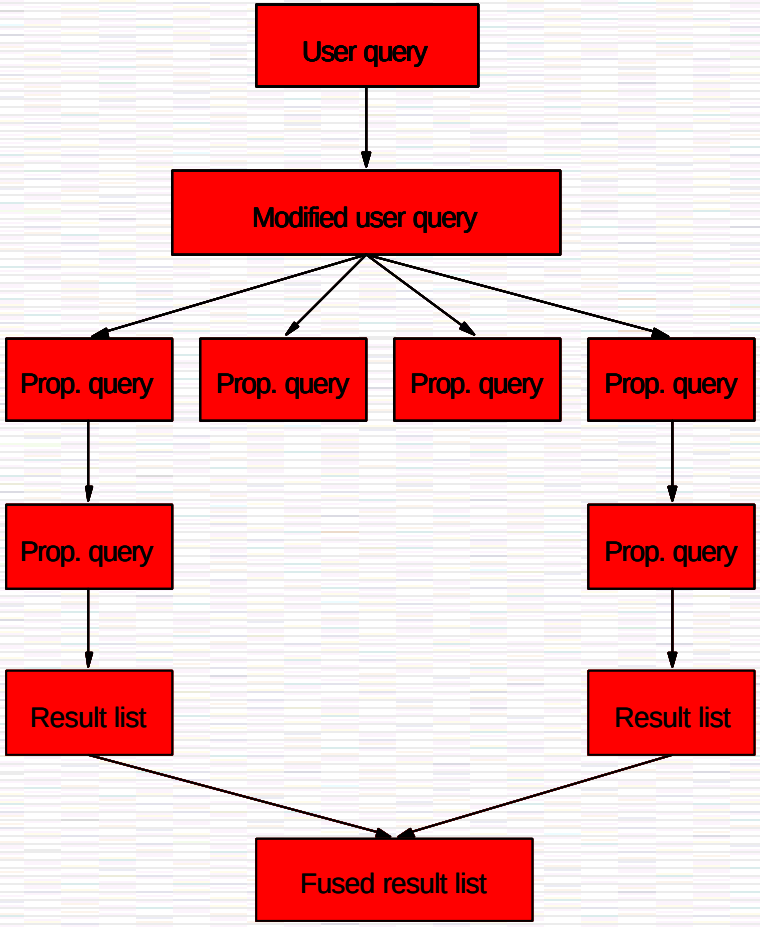
MIND Architecture



Integration



Searching with MIND



Query modification

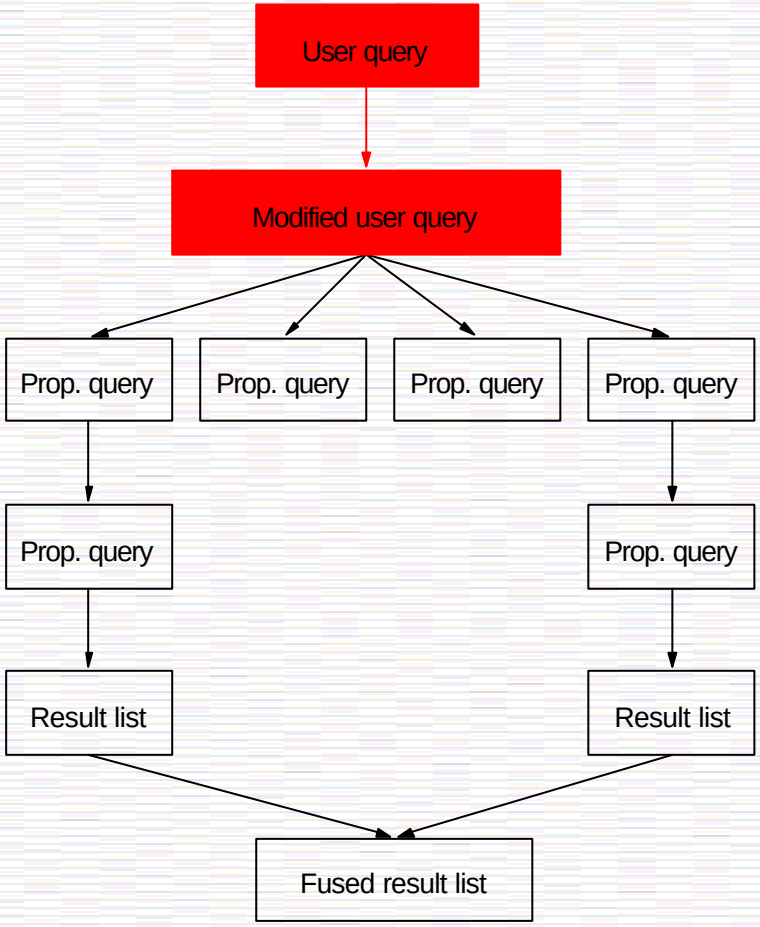
Query transformation

Resource selection

Database query run

Data fusion

Query Modification



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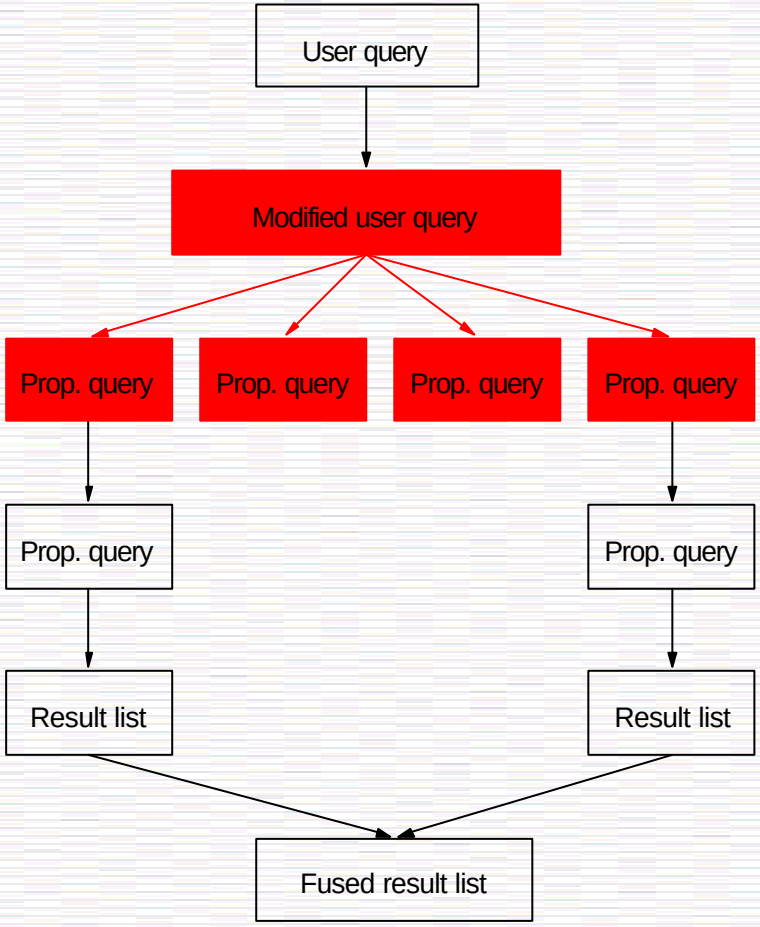
Query Modification

- Tasks:
  - capture user information need
  - add more information about the user
  - query expansion w.r.t. relevance feedback data
- Actions:
  - Interface: captures information need in a multimedia query
  - Dispatcher: adds new conditions/modifies conditions and weights w.r.t. relevance feedback features
  - Proxies: generate DL-specific features

Query Transformation



Query modification

Query transformation

Resource selection

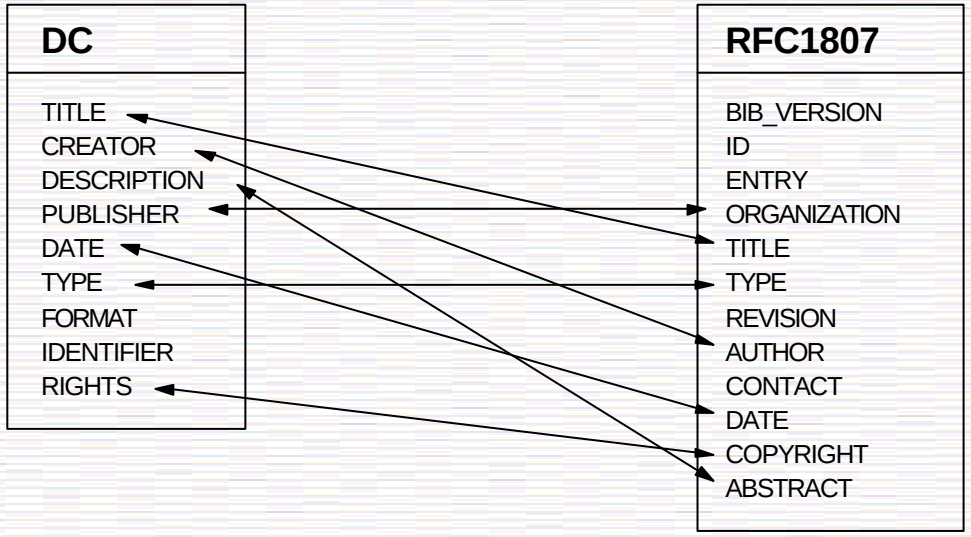
Database query run

Data fusion

Why Query Transformation?

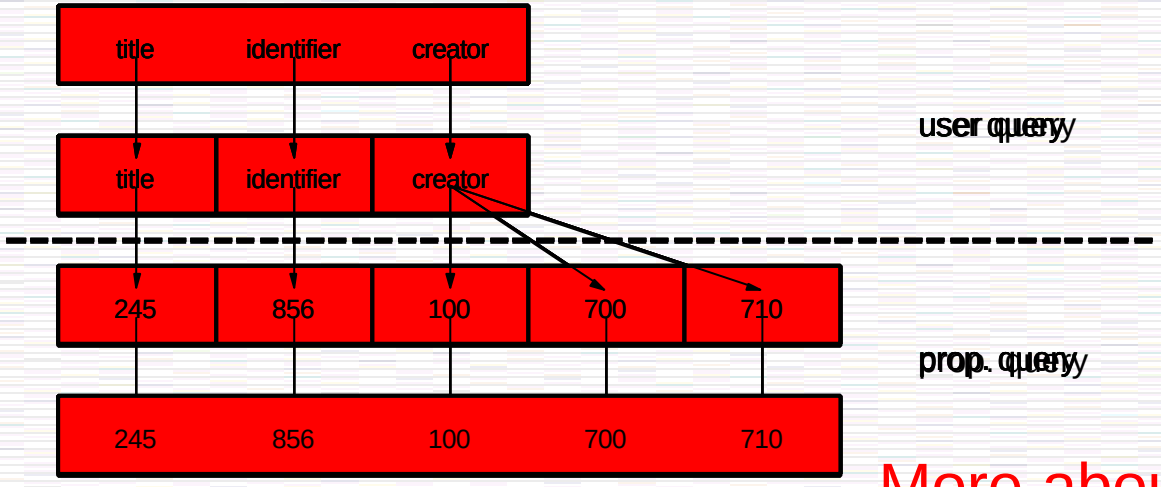
- Motivations:
  - Heterogeneous schemas
  - Thus: (uncertain) mapping between schemas to transform user query into proprietary query

- Example:
  - Dublin Core
  - RFC 1807



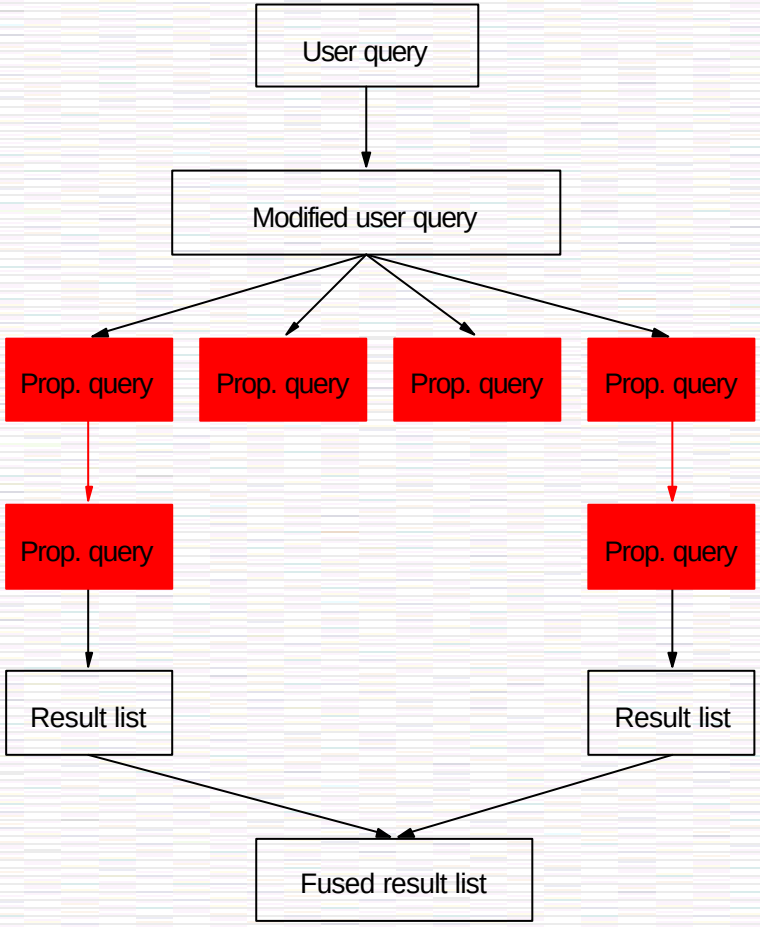
Query Transformation

- Task:
  - transform query w.r.t. different schemas
- Actions:
  - Proxies: transforms query condition by condition



More about this later

Resource Selection



Query modification

Query transformation

Resource selection

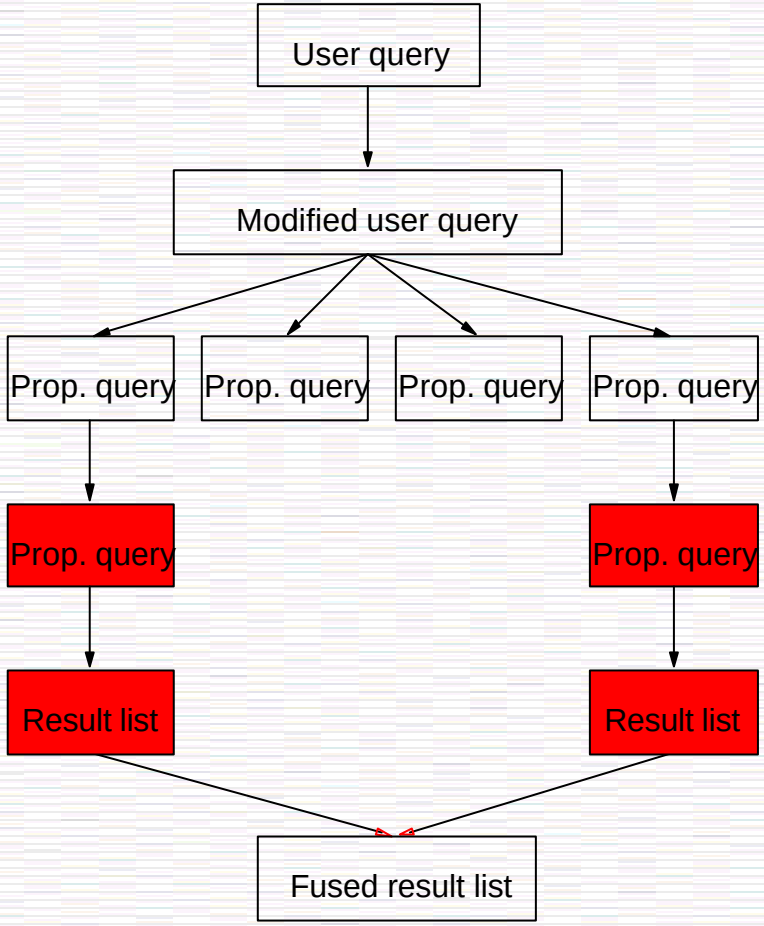
Database query run

Data fusion

Resource Selection

- Task:
  - find DLs that are relevant to the query
  - use decision-theoretic model:
    - use resource descriptions
    - cost factors (e.g. monetary costs, computation and communication time, retrieval quality)
- Actions:
  - Dispatcher: calculates for every DL the number of documents to retrieve so that overall expected costs are minimized and retrieval quality is maximised
  - Proxies: calculate specific costs for retrieval

Query Run



Query modification

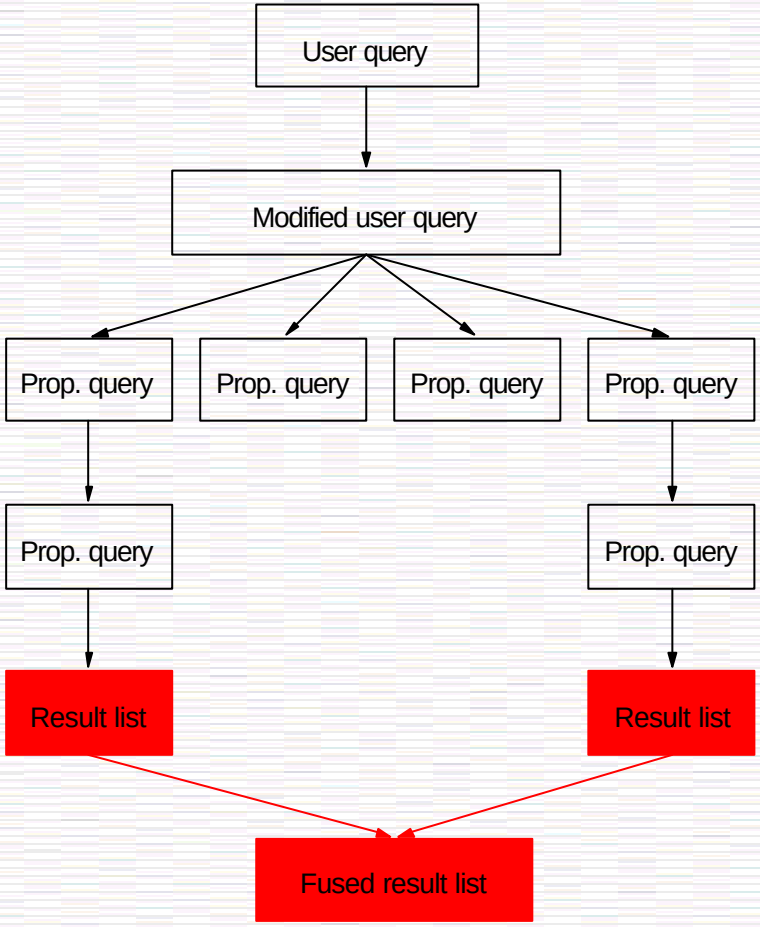
Query transformation

Resource selection

Database query run

Data fusion

Data Fusion



Query modification

Query transformation

Resource selection

Database query run

Data fusion

Data Fusion

- Task:
  - fuse together results from different DLs
- Actions:
  - Dispatcher: detects and eliminates duplicate documents (ID or content-based); modifies document weights to improve retrieval quality using global information from resource selection process
  - Data fuser: merges result lists using local information
  - Interface: creates summaries or surrogates; presents results

MIND and OAI

- Why should MIND be of some interest to OA Forum?
  - Completely different approach:
    - assumes no cooperation from DLs
    - content-based retrieval
    - no local repository of harvested metadata
  - Lessons on:
    - resource description acquisition for content-based retrieval (multimedia query-based sampling)
    - schema mapping

Creating Resource Descriptions

- Task:
  - create and update resource descriptions
- Actions:
  - Proxies:
    - start resource gathering at self-defined times
    - uses query-based sampling
- Resource descriptions are used in almost all phases of query processing

Query-base sampling

- Technique developed at CMU
- How does it work:
  1. iterative retrieval of documents using random queries
  2. assumption: union of results is representative for whole collection
  3. extract resource description w.r.t. document sample
- We have extended QBS to multimedia DLs
  - resource descriptions for images and speech

Schema mapping

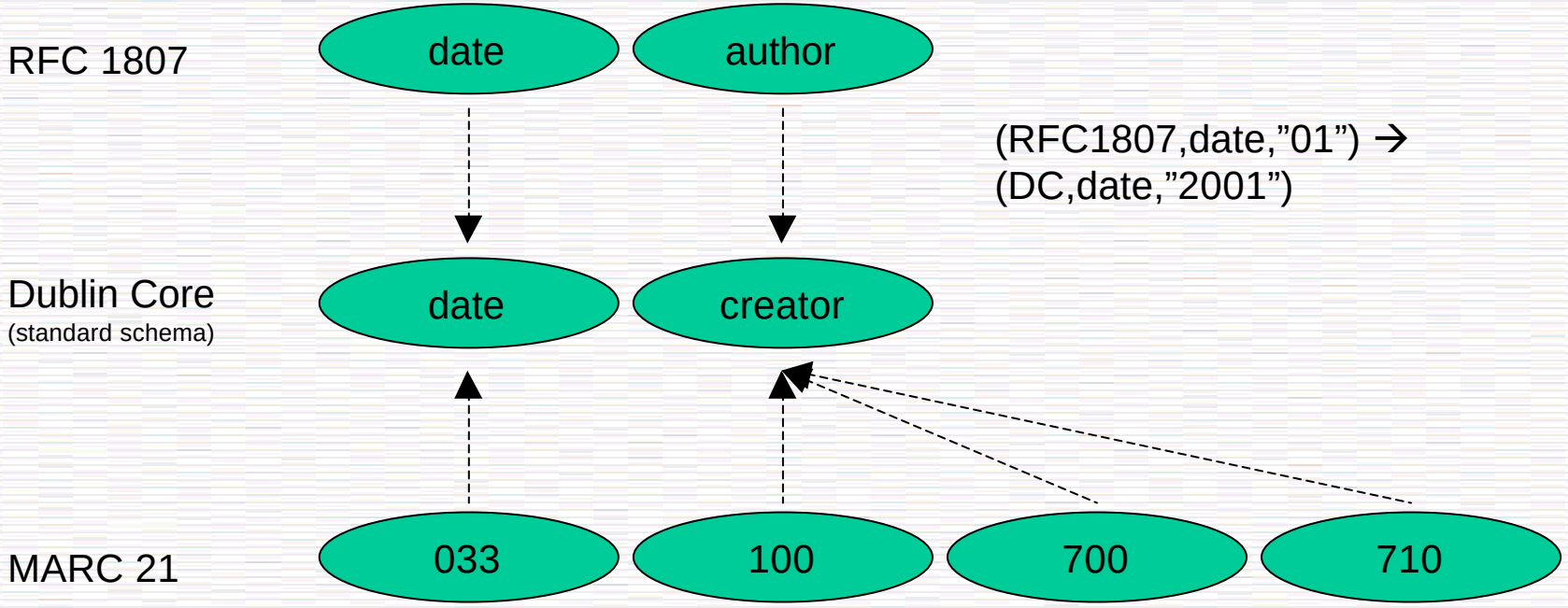
- Heterogeneous DLs with different schemas require schema mapping
- MIND uses Probabilistic Datalog (UNIDO)
- Schema mapping is carried out at document and query level
  - schema mapping at document level is necessary for relevance feedback
- Handling:
  - queries/documents encoded in RDF/XML
  - transform rules into XSLT

Creating schema mapping rules

- Generating rules from the schema
  - find indicators for matching attributes
    - E.g. attribute names, datatypes (equality, sub-datatype)
  - compute probability for each attribute pair (Probabilistic Datalog), taking most likely candidates
- Rules created automatically, but still possible to modifying them manually
  - significant error rate

Schema mapping at document level

Documents:



Schema mapping at query level

Queries:

Dublin Core
(standard schema)

creator/soundex

(DC,creator,soundex) →
(MARC21,100,sounds-like)
with probability 0.6

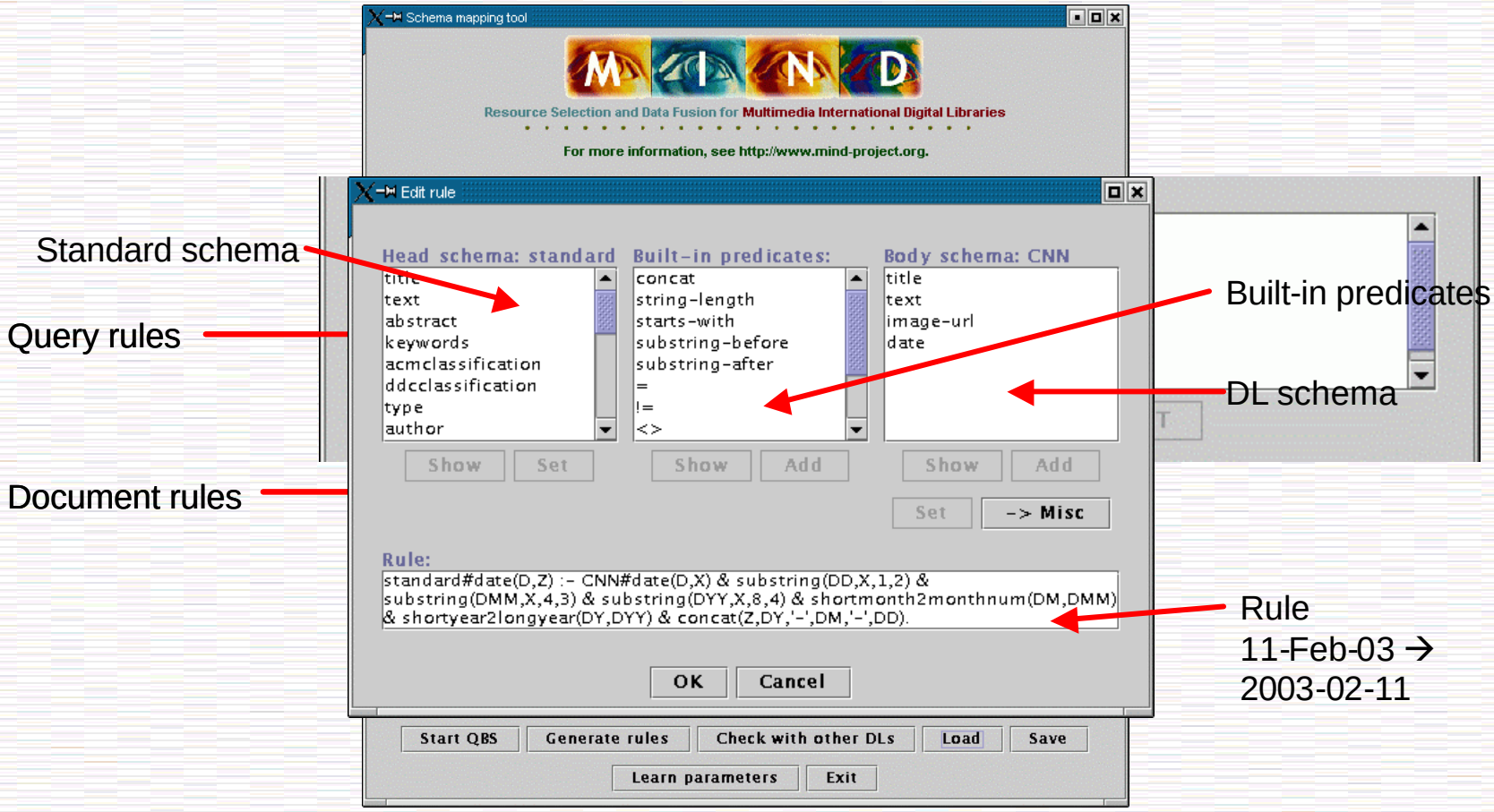
MARC 21

100/sounds-like

700/sounds-like

100/sounds-like

Creating schema mapping rules



Conclusions

- MIND and OAI are very different in their assumptions about data, users, kind of searches, etc.
- Are MIND and OAI different solutions to the same problem?
  - MIND tries to deal/live with chaos
  - OAI tries to bring order in the chaos